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Analysis of Students Chemistry Laboratory Literacy in High School

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Abstract: This research aims to identify the laboratory literacy level of SMA/MA students in Mataram City and describe laboratory literacy in 4 aspects: context, content, competence, and attitude, in carrying out practicums in the laboratory. Laboratory literacy measurement techniques through stages pre-lab to measure the ability of the content aspect, namely identifying knowledge initial or basic concepts that support practicum, subsequent stage *lab work* to measure context aspects, namely problem identification, analysis objectives, and principles of analytical methods for testing scientific ideas, and attitude aspects during practicum. Stage*post lab* measuring competency aspects related to data analysis from practicum results as a basis for decision making. The research data was analyzed descriptively. Research results show that value. The average student laboratory literacy in the context and attitude aspects is high, namely 78.22 and 86.8, but for the content and competency aspects, it is still low, namely 54.26 and 54.15. The conclusions of this research are as follows: (1)Ability The average laboratory literacy of SMA/MA students in the city of Mataram is a category enough, namely 67.71. (2) The ability to apply chemistry to real-life problems (Chemical Literacy) can be improved by optimizing the use of laboratories as chemistry learning centers.

Keywords: Chemical Literacy; Laboratory Literacy; Scientific Literacy.

Introduction

Increase participant competency education when it is hoped that this can adapt to developments in science and technology, namely emphasizing competence in behavior and using knowledge and skills to carry out tasks in school, society, and the environment where the concerned interact. [1] Science as basic science plays a vital role in the development of science and technology because science is always needed by society to form scientifically literate human resources, thus requiring reform in science teaching, which can be realized in scientific literacy activities [2]. Scientific literacy is part of scientific literacy in the capacity to use scientific knowledge to identify questions and draw conclusions based on facts and data [3]. According to [4], scientific literacy is mastery of knowledge and the ability to apply it to real problems in life. Literacy Science refers to thinking critically in identifying a problem, formulating a hypothesis, and designing and conducting research, so understanding scientific facts and relationships with science, technology, and society is very important [5].

Understanding chemistry and the ability to apply it in everyday life is called chemical literacy [6]. According to [7], learning chemistry is expected to develop chemical literacy in students, so learning is required through a chemistry practicum process.

A laboratory can be defined as a "workplace" specifically for scientific research purposes [8]. Utilization of laboratories for activities practice is part of the teaching and learning process [9]. Based on the description above, laboratory literacy is part of scientific literacy because science cannot be separated from the laboratory. [10] Learning science, especially chemistry, is centered on knowledge and understanding and is applied in everyday life. [11] Laboratories in chemistry education can be used to determine what and how a chemistry teacher practices science process activities such as observation, measurement, comparison, classification, and evaluation [12]. Practicing in the laboratory helps students understand and improve their critical skills to increase their scientific literacy [13].

According to the Programme for International Student Assessment (PISA), scientific literacy includes laboratory abilities such as identifying problems and drawing conclusions based on evidence to understand and make decisions about observed phenomena [3]. Laboratory literacy in context relates to basic laboratory abilities, which consist of the ability to describe tools along with their functions, the ability to describe materials and their properties and functions, and the ability to describe safety in the laboratory to look for concrete evidence. [14] Content aspects in laboratory literacy include knowledge that supports conducting practical laboratory activities. In contrast, laboratory competency specs focus on the mental

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processes involved when answering a question or solving a problem [15] by identifying variables in chemical investigations. At the same time, Attitude aspects can be shown how the attitude is to chemical experiments that can be carried out in the laboratory [16]. Based on the description above, laboratory literacy in this research uses the laboratory to identify problems, understand the purpose, and gather evidence to conclude.

Several studies that reveal scientific literacy data, including the Programme for International Student Assessment (PISA), have reported that the scientific literacy abilities of students in Indonesia are still low. Results Research [17]explained that the low level of high school chemistry literacy was due to students' inability to understand the analysis of the relationship between concepts, so they cannot synthesize them to draw conclusions related to existing facts in life. [10-14] have analyzed laboratory literacy levels, including understanding the function of equipment, introduction to materials at a basic level, as well as understanding laboratory safety. Practical assistance in the laboratory can improve laboratory skills such as introduction and use of tools and materials, as well as how to maintain personal safety in the laboratory [18], this is in line with the results of research [19] which explains that workshops and practice in the laboratory can improve chemical literacy skills.

The current problem is the utilization of laboratories in SMA / MA schools in the city of Mataram as the center for learning chemistry is still not optimal, and there is no data yet to reveal chemical literacy skills, especially laboratory literacy. For this reason, it is necessary to identify laboratory literacy among SMA/MA students so that the role of laboratories in increasing scientific literacy can be known. It is also a challenge for the Chemistry Education Study Program to produce capable teacher candidates with high chemical literacy levels to maximize laboratories in schools as chemistry learning centers. Based on these problems, this research aims to (1) Identify the laboratory literacy level of high school students in Mataram City and (2) Describe laboratory literacy in 4 aspects, namely context, content, competencies, and attitudes in carrying out practical work in the laboratory.

Research Methods

Subject to this research, as many as 48 students from SMA/MA in Mataram City. This research is descriptive because it aims to identify and describe the level of laboratory literacy. The laboratory literacy measurement technique is carried out in 3 stages: pre-lab, Lab work, and post-lab. Level Pre-lab measures the ability of the content aspect, namely identifying knowledge initial or basic concepts or variables that support the implementation of practicum; subsequent stage lab work (practicum implementation) measures context aspects, namely identifying problems and objectives of analysis, concepts, and analytical methods to prove ideas. and aspects of attitude during practicum. Stagepost lab measures competency aspects of analyzing practicum data to make decisions or conclusions. The research data were analyzed descriptively to explain students' laboratory literacy level, and the level of literacy was expressed by referring to [7].

Results And Discussion

Laboratory literacy, referred to in this research, is the ability to utilize a laboratory to identify problems, understand objectives, and collect scientific evidence to conclude. Students' laboratory literacy abilities are measured on volumetric topics to solve problems in determining up to $Mg(OH)_2$ and $Al(OH)_3$ in antacid drugs, consisting of applying standardization and titration concepts for determining substance levels in a sample. The instrument is designed to work in a laboratory or practicum and consists of pre-lab, lab work, and post-lab work. Laboratory literacy measurements are carried out in groups, and each group consists of 3 students. Laboratory literacy aspects measured include content, competency, context, and attitudes during the practicum implementation in the laboratory. Indicators for each element of laboratory literacy are as in Table 1.

Table 1. Indicators for each aspect of laboratory literacy

Aspect	Evaluation Indicators
Content	Identify initial knowledge or basic concepts or variables that support practicum implementation.
	Standardization
	Calculate Mr standard substance $H_2C_2O_4$. $2H_2O$
	Calculating the moles of 0.65g $H_2C_2O_4$. $2H_2O$
	Balancing titration reactions
	a NaOH + b $H_2C_2O_4$. → c $Na_2C_2O_4$+ d H_2O
	Determine the mole ratio of NaOH and $H_2C_2O_4$.
	Determination of Substance Rate
	Calculating Mr $Mg(OH)_2$ and $Al(OH)_3$
	Calculating Moles of: 200 mg $Mg(OH)_2$ and 200 mg $Al(OH)_3$
	Balancing reaction equations
	a $Mg(OH)_2$ + b HCl → c $MgCl_2$ + d H_2O

	a $Al(OH)_3$ + b HCl → c $AlCl_3$ + d H_2O
	Determine the mole ratio of $Mg(OH)_2$ and $Al(OH)_3$ and HCl in reaction no. 3
Context	Identifying problems, basic concepts, and methods of analyzing ideas or scientific ideas
	Understand the problems and objectives of the analysis
	Recognize analytical methods
	Identify tools and materials for designing ideas
	Using tools and materials for analysis
Competence	Analyze and evaluate practicum data to make decisions.
	Write down the reactions that occur during a standardization titration.
	Calculate the concentration of standardized solutions.
	Write down the reactions that occur during the titration of an antacid solution.
	Based on practical data, count $Mg(OH)_2$ and $Al(OH)_3$ levels in antacid drugs.
Attitude	Attitude towards practicum
	Accuracy in collecting data
	Maintain work safety in the laboratory.
	Accuracy in work

Based on table 1 above shows that laboratory literacy indicators include initial knowledge, or basic concepts that support practical concentration determination $Mg(OH)_2$ and $Al(OH)_3$ in antacid drug samples, identify problems, basic concepts, and methods of analyzing ideas or scientific ideas, and analyze and evaluate practicum results data to make decisions. The topic of antacid drugs lifted because the use of these drugs is widely applied in everyday life. At the problem orientation stage, students are given articles related to drug use stomach antacids and their relationship with the titration method to determine $Mg(OH)_2$ levels and $Al(OH)_3$ contained in the drug. Results of laboratory literacy measurements for SMA/MA students in Mataram. The average value obtained is listed in Table 2.

Table 2. Laboratory Literacy Ability of SMA/MA Students

No	Aspects of laboratory literacy	Rate Rate	Criteria
1	Context	78.22	Height
2	Content	54.26	Low
3	Competence	54.15	Low
4	Attitude	86.8	Height
	Rate Rate	67.71	Enough

Table 2 shows that the laboratory literacy abilities of SMA/MA students are at category sufficient, namely 67.71, which means that the ability to apply chemistry to real work still needs improvement. In detail, context aspects of the category are high, with an average score of 78.22 and an attitude aspect of 86.8. This illustrates that students can conduct analytical work procedurally, according to objectives, and collect data carefully. The content aspect has an average value of 54.26 on category low, which means the ability to identify knowledge or basic concepts that support practicum implementation and analyzing practicum results in data to make decisions or conclusions still needs improvement.

Aspects of Laboratory Literacy Content

The content aspect of laboratory literacy is related to identifying knowledge of initial or basic concepts or variables that support practicum implementation. The initial expertise measured is the ability to calculate Mr of a pure compound, determine the number of moles, balance equations reaction, and choose the mole ratio of substances that react. This knowledge is needed to standardize solution titrations and determine substance levels. Comparison of the average scores for the content aspects of each topic as in Figure 1

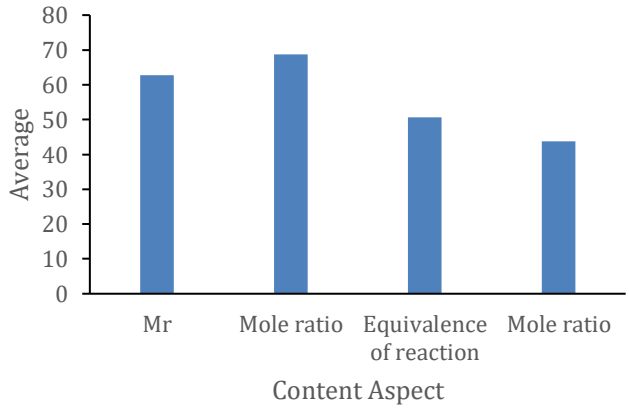

Figure 1. The average value of content aspects for each concept

Based on Figure 1 above, it can be explained that initial knowledge about Mr standard substance is still in the category. The sufficient reason is that students do not understand how to calculate Mr of a pure substance with crystal water. Students generally answer Mr compound without adding Mr crystal water. This error supports that the average value when calculating the number of moles is also not optimal. The concept of calculating the number of moles is mastered, but due to concepts, counting me as someone who doesn't understand impacts the application.

Regarding balancing reactions, mole ratios provide an average value in the category low because students cannot balance reaction equations and determine mole ratios for real ones. Samples containing mixed compounds Mg (OH)2 and Al(OH)3 will react with the reagents simultaneously. This also shows that students do not seem to get to know the standard materials in the laboratory because there are generally chemicals in the laboratory that contain crystal water. By learning in the laboratory, students can get to know chemicals directly and see information about the material, such as chemical formula, Mr, purity, and the nature of the material, which is very different from theoretical learning in class.

Aspects of Laboratory Literacy Competency

Indicator aspects of laboratory literacy competency include analyzing and evaluating practicum data to conclude. The average value of the measurement results for the laboratory literacy competency aspect is still low, namely 54.15. This gives the idea that students cannot yet describe practicum results data, which results in inaccurate conclusions being determined. This is the effect of low initial abilities, which is probably because the students did not design the practicum, so they tend to be too lazy to understand and Follow practical instructions. Analysis practicum result data is significantly influenced by their initial knowledge, so if initial knowledge is low, then students cannot carry out data analysis; this is very in accordance with the data from the students' laboratory literacy measurements. A lack of understanding of calculating Mr will affect the results of calculating the number of moles of a substance. Likewise, the low ability of the reaction balancing concept will result in a low mole ratio concept for determining the amount of the substance being sought. To improve the competency aspect, it is necessary to synchronize learning theory and practice with material related to real life. The use of laboratories can be used to see what and how to observe, measure, compare, classify, evaluate, and better understand, and it can improve critical skills, thereby increasing literacy [12].

Aspect Context

Aspects of the laboratory context relate to identifying problems, basic concepts, methods of analyzing ideas, or scientific ideas in the form of practical work. Indicators of context aspects in this research include understanding the problems and objectives of the practicum, recognizing analytical methods, identifying tools and valuable materials, and using tools and materials to carry out helpful work correctly. The average value of the students' laboratory literacy context aspects is a category tall. This shows that students can carry out the practicum by following the instructions correctly. High-aspect context laboratory literacy also includes the possibility of many online reading materials or additional teaching materials for students that support students' laboratory literacy activities. This is the opinion of [20] that learning experiences using appropriate teaching materials can increase scientific literacy.

Aspects of laboratory literacy attitudes

The average value of students' laboratory literacy attitudes is 86.8, which means students can collect data carefully and according to observations. This attitude can develop an attitude of honesty and hard work. Apart from that, students can maintain personal safety against the dangers of using chemicals and glassware, considering the working conditions in the laboratory, which involve chemicals that can cause danger if not used according to procedures and uses. Students' ignorance can cause health hazards such as carcinogenic chemicals, fire hazards, poisoning, and possible electric shocks when using laboratory equipment. Students can determine the accuracy of work by measuring volume, dissolved chemicals, moving solutions, and choosing the equivalence point. This shows that there has been an opportunity for students to work in the laboratory directly or virtually, so students' knowledge is excellent. The high level of students' laboratory literacy attitude also shows that the learning process has been carried out in the laboratory or providing materials or teaching materials that support behavior in handling chemicals.

Conclusion

The conclusions of this research are the average laboratory literacy of SMA/MA students in the city of Mataram is category sufficient, namely 67.71 with the following details: context aspect of 78.22 on category high, content aspect of 54.26 with category low, competency aspect of 54.15 on category low and attitude aspects on category high with an average score of 86.8. Applying chemistry to real-life problems (Chemical Literacy) can be improved by optimizing laboratories as chemistry learning centres.

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